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Competition and evolution of linear and two-part tariff☆

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ABSTRACT

The duopoly competition model presented in this paper tries to explain why a two-part tariff exists in the telecommunication industry. The investigation of competition and evolution between linear and two-part tariffs shows how the growth of the market and the sequence of action may affect equilibrium. The two pricing patterns are assumed to be virtual participants to constitute a tariff competition and evolution model, and by calculation, we can obtain metaphase equilibrium and evolution equilibrium. The conclusion shows that optimized Pareto equilibrium should be carried out by combining linear pricing and buffet pricing, this case being presented as a three-part tariff when many sub-markets coexist.

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1. Introduction

In the telecommunication service area in 1983 AT&T first started to use a two-part tariff with a fixed fee and a price per unit purchased. Following this trend, many telecom companies such as MCI, KDD set this kind of tariff to diversify the tariff system. Today, the two-part tariff has almost replaced linear mode in every sort of telecom service. By attributing to a market subdivision strategy, a two-part tariff gives customers the authority to choose according their consumption model. Also it can stimulate consumption effectively by reducing the price per unit compared with a linear tariff.

In competitive markets firms commonly use many kinds of tariff to compete with each other including linear, two-part, three part and bound, ordering tariff. The Chinese telecom market pertains to a duopoly in which furious competition has lasted from 1999 until now. Accompanied by continuing discounts, the Chinese telecom market's successfully developed, cell phone becomes trivial with the total number of consumers with a land-line phone exceeding 420,000,000. However, Chinese companies chronically frame tariffs by intuition or by imitating foreign telecom companies due to the lack of pricing pattern related research. So, pricing pattern related research is significant not only as a means of instructing firms but also to enable government to manage the telecom industry and enhance social welfare.

There is a rich literature on two-part tariff pricing monopolists that deals mainly with optimal pricing strategies and price discrimination [1–5]. The Cournot case refers to Ireland, and the Bertrand case in Mandy and Katz constructed a model that considers monopolistic competition. A review of this literature can be found in N. Babu, Joyee Dutt comparing the profit of two-part tariff and buffet pricing under differentiation models. Solange Berstein's model tried to explain why firms may prefer a two-part tariff to a single price in a competitive market and the relationship of these prices to the existing switching costs in these industries, and addressed the effects of a two-part pricing structure on social welfare by modeling the horizontal differentiation games. On the other hand, there is vast literature about the comparison between linear and two-part tariffs but these documents do not consider the possibility of constructing a game model to explain the evolution of pricing patterns in a developing market. There are models that deal with differential services with two-part tariff pricing

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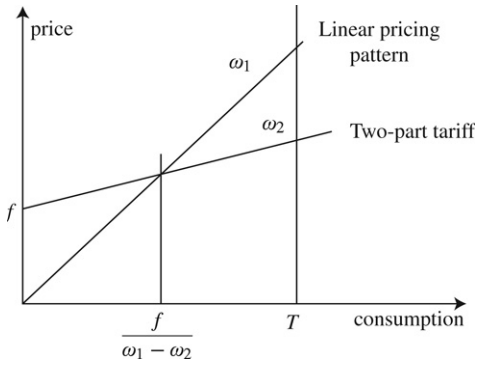

Fig. 1. Horizontal homogenization model.

under Cournot, Bertrand and monopolistic competition, nevertheless, these models do not include homogenous services under duopolistic competition.

The model presented in this paper tries to explain why a linear pricing pattern loses its power when the telecom market is developing, and what priority a two-part tariff has within tough competition. The aim is to find a way to research the optimization of pricing patterns in order to enhance social welfare.

2. The model

For simplicity this paper starts with a duopoly model with homogeneous products without consumption elasticity. The pricing structure is such that one participant uses linear and the other uses a two-part tariff. The model shows how firms compete by setting their fixed fee and price per unit [6].

It is assumed that demand is inelastic, the number of consumers is fixed and each individual demands a certain amount independent of the price. Nevertheless, different customers demand different amount of service (q), which is assumed to be uniformly distributed on interval $[0, T]$. The cost of providing the service to one more consumer is constant and equal to c. ω_1, represents the price per unit of linear tarrif while that of the two-part tariff is denoted by ω_2, Including model restriction: $\omega_1 > \omega_2 > 0, f > 0$, and customers below $\frac{f}{\omega_1-\omega_2}$, consumption use a linear pricing pattern, therefore pay $q \times \omega_1$, while customers with consumption above $\frac{f}{\omega_1-\omega_2}$ prefer two-part tariff and therefore pay $f + q \times \omega_2$. Refer to Fig. 1.

Elements of the game are as follows:

(i) Participants are linear and two-part tariff;
(ii) Linear comprises price per unit while two-part tariff comprises fixed fee along with price per unit;
(iii) Payoff of each participant: Revenue represented by R_1 and R_2.

3. Solution

3.1. Solution of static game

Stages of the game are as follows:

Stage I Nature uniformly re-distributes customers' consumption along the line segment $[0, T]$;
Stage II Two-participants decide their fixed fee and price per unit contemporarily.
Stage III Customers decide which tariff to buy.

Proposition 1. *Under competition, with the same cost of c and duopoly, firms use linear and two-part tariff, the unique symmetric Nash equilibrium of static is:*

$$\begin{cases} \omega_1^* = c + \dfrac{f}{\sqrt{2}T} \\ \omega_2^* = c - \dfrac{f}{\sqrt{2}T} \end{cases} \tag{3.1}$$

$$\begin{cases} R_1 = \dfrac{Tf}{4\sqrt{2}} \approx 0.1768Tf \\ R_2 = \left(1 - \dfrac{5}{4\sqrt{2}}\right) Tf \approx 0.1161Tf. \end{cases} \tag{3.2}$$

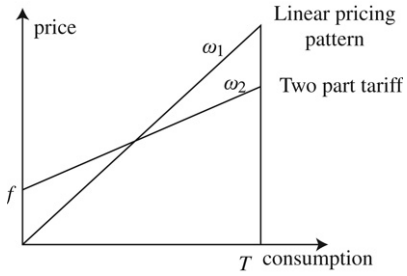

Fig. 2. Initial game settings.

3.2. Solution of dynamic game

Stages of game:

Stage I Nature uniformly re-distributes customers' consumption along the line segment $[0, T]$;
Stage II Two-part tariff decide its fixed fee and price per unit;
Stage III Linear pricing pattern decide its price per unit;
Stage IV Customers decide which tariff to buy.

Proposition 2. *Under competition, with a same cost of c, and duopoly firms use linear and two-part tariff tariff, the unique symmetric Nash equilibrium of dynamic is:*

$$\begin{cases} \omega_1^* = c + \dfrac{\sqrt{3}f}{2T} \\ \omega_2^* = c - \dfrac{\sqrt{3}f}{2T} \end{cases} \tag{3.3}$$

$$\begin{cases} R_1 = \dfrac{\sqrt{3}Tf}{12} \approx 0.1443Tf \\ R_2 = \left(1 - \dfrac{\sqrt{3}}{2}\right) Tf \approx 0.1340Tf. \end{cases} \tag{3.4}$$

4. Equilibrium analysis

From Eqs. (3.1)–(3.4) we conclude that the competitive equilibrium implies that the optimal setting for linear pricing pattern is higher than margin cost while the two-part tariff one sets below it. It can be easily explained that the linear needs to gain not only its cost but also the profit. Setting the price per unit above margin cost can guarantee this. Meanwhile a two-part tariff can obtain profit by a fixed fee. In order to acquire a higher market share, the most competitive way is to reduce the price below margin cost.

On the other hand, in the dynamic game the payoff of the two-part tariff is higher and under any circumstances the payoff of the two-part tariff is slightly inferior. But when element T varies, the two-part tariff can coordinate the change by adjusting its fixed fee. Linear pricing pattern configures its optimal settings by two-part tariff settings.

By considering the fact that the practical distribution of consumption is more likely to be a Poisson distribution under which if the market continues to develop, the market share of low-level customers may shrink. Besides, this result holds under the assumption of inelastic demand. If we release that assumption and assume the consumer is flexible, this phenomenon may fiercer than we estimated and we can deduce the fact that the two-part tariff is predominant in competing with the linear tariff. Moreover, firms do not compete with only a few pricing pattern, they always build several different tariffs to cater for the specific needs of each market subsection. So, two firms accordingly turn to constitute nonlinear tariffs to dominate the developing market and the main pricing pattern evolves from linear to two-part, and then to three-part. Bounding, ordering, and three-part tariff is most popular at present.

According to this analysis, we can deduce that there are four stages of evolution when linear competes with two-part tariff in the static game in a developing market as the Figs. 2–5.

The first step of linear pricing is to reduce its price to increase profit by enlarging the market share. As calculated in this period, the two part tariff has to reduce its price lower than margin cost (refer to Fig. 3). Then, the linear pricing pattern can not tolerate a reduction because at such a low price level even the whole market could not guarantee a favorable payoff It would be as well to raise the price, conceding some market share to the two-part tariff. So, they can achieve an equilibrium shown in Fig. 4. Moreover, after achieving the midterm equilibrium, the two-part tariff has enough motivation to increase the fixed fee and reduce the price per unit so as to pursue a higher profit. Meanwhile, the linear pricing pattern's optimal strategy is to increase the price per unit. Therefore, the last Pareto equilibrium is finally obtained as shown in Fig. 5.

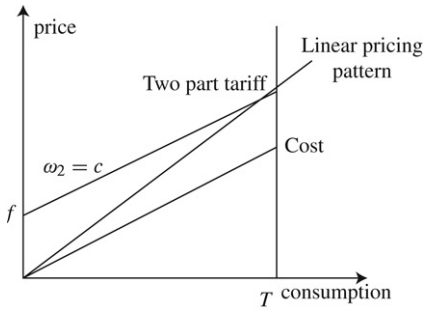

Fig. 3. Prophase of equilibrium.

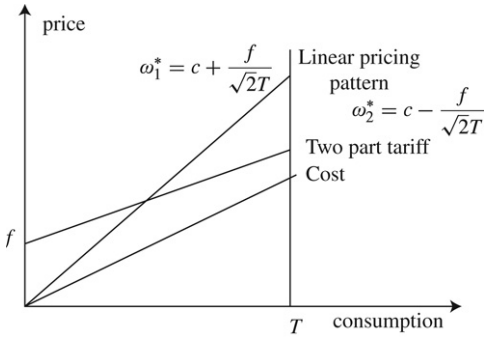

Fig. 4. Metaphase equilibrium (certain fixed fee).

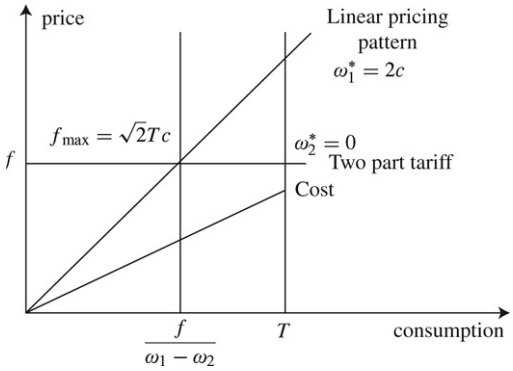

Fig. 5. Evolution equilibrium (static game).

The intuition of this result showed that f affects payoff directly, so the increase of f is significant by means of enhancing profit and accelerating the tariff evolution. The restriction of f is to satisfy $\omega_2 > 0$ then we can calculate that $f_{\max} = \frac{2\sqrt{3Tf}}{3}$. To maximize profit the optimized solution is $\omega_1^* = 2c, \omega_2^* = 0$. Namely, the two-part tariff becomes buffet pricing.

Since the two-part tariff exists in market competition, the optimal settings for the two-part tariff to compete in a particular subsection is a specific oneno price per unit, and a high fixed fee (equal to buffet pricing). The dynamic Pareto optimal equilibrium can be deduced as shown in Fig. 6.

Confirming that the last phase of evolution is buffet pricing, we can deduce that the whole market may be subdivided as shown in Fig. 7 When a multi-pricing pattern exists to operate in many submarkets, the final optimal form of subdivision is somewhat a combination of buffet pricing and linear pricing. Calculation and analysis shows under the assumption of uniformly consumptive distribution the existence of a combined pricing pattern, what we now call a three-part tariff.

In Fig. 7, the whole market is divided into more than three submarkets, this sets the pricing strategy as optimal settings in each submarket as linear and buffet pricing. Because buffet pricing operate in a definite area over consumption cannot be prevented so there must be regulation to charge the excess consumers more to provide balance. Coordinating with the linear pricing pattern in adjacent submarkets, a new pricing pattern is formed to fulfill our needs—three-part tariff.

If we add the elastic into consideration, another advantage of two-part tariff should not be ignored. Low price per unit prompts excess consumption, developing linear tariff users into two-part tariff users. Assuming customers' consumption

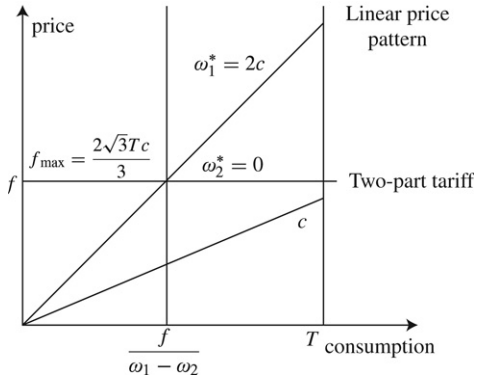

Fig. 6. Evolution equilibrium (dynamic game).

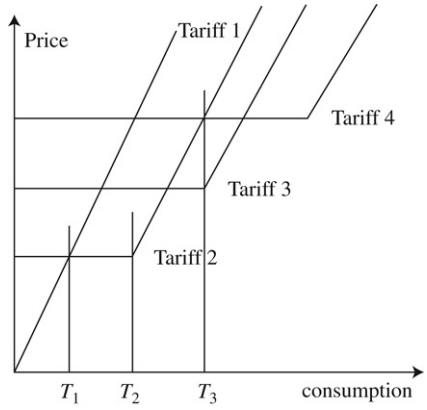

Fig. 7. Optimal market subdivision.

is distribute randomly, customers choose a tariff according their anticipation [7], because nobody can estimate his or her own consumption precisely. People around a submarket boundary are more likely to use a tariff which is higher in fixed fee and lower in price per unit. According to these advantages, it is clear that a two-part tariff is more suitable than a linear pricing pattern in a developing market. One illustration is that after the existence of a linear pricing pattern in 1999, the linear pricing was rapidly substituted by two-part tariff. It is rare to find anyone who uses a linear tariff in 2001.

If two firms cooperate, they can increase f and ω_1 to achieve more payoff, but it will obviously harm the utility of users.

The model illustrated that it is inevitable that a two-part tariff will come into existance in a competitive homogeneous developing market [8]. Why is it hard to see two-part tariff in retail market such as supermarket, ice-cream shop? Numbers are low (tiny T) in these markets, and these places are usually insufficiently competitive and this is the main effect that prevents the existence of a nonlinear tariff. In other high consumption markets if sufficiently competitive, for instance, swimming clubs, fitness clubs or golf clubs, a two-part tariff is more competitive due to heavy regular custom. Of course, a linear pattern always finds its way on these low need customers. On the other hand, if two pricing patterns are controlled by one firm (lack of competition), the only consideratoin becomes how to gain more surplus from many kinds of customers. This may lead to discrimination or other artifices.

To sum up, compared with linear pricing pattern, two-part tariff is more encouraging, more adjustable, and has many other advantages especially in a developing market. Results show that the equilibrium price per unit of a two-part tariff is lower than margin cost.

5. Conclusion

The previous model suggests that under product homogenization with competition, a two-part tariff is superior. Three stages of game evolution are figured out and the final result predicts the existence of a three-part tariff. In this case, we indicate the optimal pricing strategy of multi-submarkets. In contrast to the Bertrand model, two firms selling the same product can obtain certain profit by differing their pricing pattern. Nevertheless, the distribution consumption determins the form of optimal solution. Under our assumption buffet pricing is the best solution in certain submarkets to compete with linear pricing.

For further analysis, it would be sensible to introduce the possibility of Poisson and elastic into this model. Bounding and ordering tariff are about to be formalized and it would be instructive to deduce the next generation of tariff. It might also be of relevance to consider the customer utility keeping the same structure used in this article.

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